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Introduction

CNS cavernous malformations (CCMs) are dilated capillary-level lesions, which have a tendency to repeated internal hemorrhage and growth and, less frequently, hemorrhage into the nearby brain. These are well known and researched in the brain. However, the same malformation can also occur in the spinal cord, also with risk of hemorrhage.

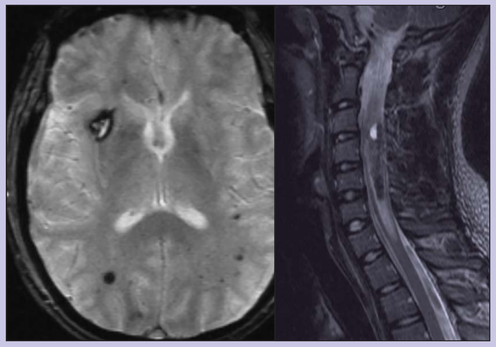

FIGURE 1
Left, typical brain CCMs, with mixed signal intensity in large lesions and small lesions with mostly hemosiderin characteristics (axial T2 gradient recall MRI brain). Right, acute hemorrhage with swelling and edema of the spinal cord (sagittal SE T2) associated with a cavernous malformation.

Brain CCMs can be either sporadic (solitary) or genetic in origin, with autosomal dominant pattern for the latter. There is a large prevalence of genetic CCM in New Mexico due to a founder effect in the early Spanish settlers. Spinal cavernous malformations (SCMs) have been termed rare in previous literature, but previous studies have been very inconsistent in identifying familal (genetic) cases. For example, Toldo et al said, "The coexistence of intracranial and spinal cavernous angiomas in familial CCM is extremely rare." (Toldo et al, Surg Neurol 2009;71:167). However, our experience in New Mexico is different. Within a large population of familial cerebral cavernous malformations, SCMs were identified in 8% of spine MRI, and the overall prevalence is likely much higher.

Multiple SCM suggest familial rather than sporadic disease, with profound implications for families, genetic counseling, and potential brain involvement.

The purpose of this study was to compare MRI sequence sensitivity indetecting SCMs in a group of patients with known familial CNS cavernous malformations.

Methods

- IRB-approved, HIPAA-compliant
- Retrospective review of 16 patients with cervical spine MRI performed for clinical indications identified from a large familial population with CCM1 mutation CCMs.
- All cervical MRIs included:
  - SE-T1 sagittal
  - SE-T2 sagittal and axial
  - 2D MEDIC
  - 9 patients also had sagittal 3D MEDIC
- Data analyzed using an ordinary two-way ANOVA with 3D MEDIC as a control and Dunnett's multiple comparison post hoc test

Results

- SE sequences (T1 and T2)
  - 1 patient with multiple SCMs
- 2D MEDIC-T2
  - 4 patients with multiple SCMs
- 3D MEDIC-T2
  - 6 patients with multiple SCMs

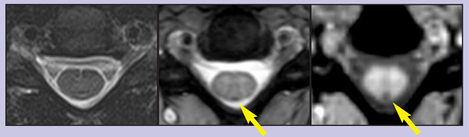

FIGURE 2
Example of axial images of SCM, spine echo T2 (left), 2D MEDIC T2 (middle), 3D MEDIC (right).

MRI SEQUENCE	ADJUSTED P-VALUE
3D MEDIC VS SAGITTAL T1	0.0009
3D MEDIC VS SAGITTAL FSE T2	0.0009
3D MEDIC VS AXIAL FSE T2	0.0009
3D MEDIC VS 2D MEDIC	0.0238

- 3D MEDIC-T2 is more sensitive than 2D MEDIC-T2.
- 2 additional patients identified as having multiple SCMS (P=0.0238).

Discussion

Gradient-based imaging is more sensitive than spine echo imaging for the detection spinal cavernous malformations. This is not surprising, but often routine clinical spine MRI, especially in the thoracic and lumbar spine, is done without gradient-based sequences. Moreover, 3D MEDIC, which is uncommonly used for spine imaging, is more sensitive than 2D MEDIC. There are also additional benefits of 3D MEDIC:

- Faster acquisition: 2-3 minutes compared to 5-7 minutes
- Sagittal acquisition permits longer segment coverage
- Isotropic voxels (1.1 mm on each side) permit multiplanar reconstuctions, as demonstrated in figure 3.

Conclusions

In a familial population, multiple SCMS are not uncommon if sensitive, gradient-based sequences are used. 3D MEDIC

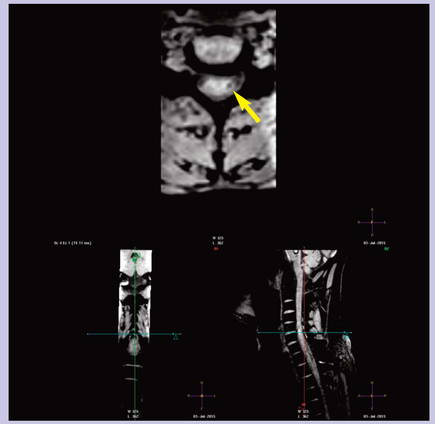

FIGURE 3 **Sagittal acquisition (lower right) permits reconstruction in multiple planes (coronal in lower left, axial plane, top).**

offers advantages over 2D MEDIC beyond sensitivity. Sensitivity is necessary as the distinction between solitary versus multiple SCMs impacts both the patient and the family. Optimal technique is important in evaluation of suspected SCMs.

If cavernous malformations are identified in the spinal cord and brain imaging has not yet been performed, we strongly recommend also obtaining MRI of the brain.

Future research directions

Limited analysis of thoracic spine MRI shows the benefit of 3D MEDIC in added sensitivity compared to spine echo. 3 of 7 thoracic MRI studies had at least 1 SCM on 3D MEDIC and no SCMS on spin echo sequences. In addition, the sagittal acquisition is even more helpful in the thoracic spine.

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